इंटरनेट मानक

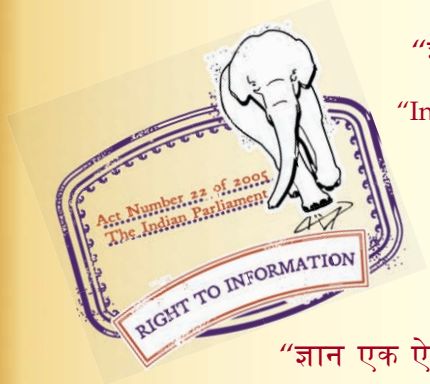
Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 8666 (1977): Copper and copper alloy covered electrodes for manual metal arc welding [MTD 11: Welding General]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

IS : 8666 - 1977
(Reaffirmed 2003)

Indian Standard

SPECIFICATION FOR COPPER AND COPPER ALLOY COVERED ELECTRODES FOR MANUAL METAL ARC WELDING

UDC 621·791·753·042·4 : 669·3

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Rs 8·00 Gr 5

March 1978

Indian Standard

SPECIFICATION FOR COPPER AND COPPER ALLOY COVERED ELECTRODES FOR MANUAL METAL ARC WELDING

Welding General Sectional Committee, SMDC 14

Chairman	*Representing*
SHRI S. V. NADKARNI	Advani Oerlikon Limited, Bombay
Members	
SHRI P. S. VISVANATH (*Alternate* to Shri S. V. Nadkarni)	
SHRI J. K. AHLUWALIA	Stewarts and Lloyds of India Ltd, Calcutta
SHRI T. K. BASU (*Alternate*)	
SHRI AWTAR SINGH	Beas Project, Talwara Township
SHRI S. BALASUBRAHMANYAM	Binny Limited, Madras
SHRI K. BALMANOHAR	Hindustan Shipyard Ltd, Visakhapatnam
SHRI S. BHATIA	Philips India Ltd, Bombay
DR J. VAID (*Alternate*)	
SHRI B. C. BISWAS	National Test House, Calcutta
SHRI R. N. CHAKRABORTY	Braithwaite and Co Ltd, Calcutta
SHRI A. K. CHOPRA	Indian Register of Shipping, Bombay
SHRI S. CHANDRA (*Alternate*)	
DIRECTOR, RESEARCH AND DESIGN (B & R BRANCH)	Public Works Department, Government of Haryana, Chandigarh
EXECUTIVE ENGINEER, MECHANICAL WORKSHOP DIVISION, NEW DELHI	Central Public Works Department, New Delhi
EXECUTIVE ENGINEER (ELECTRICAL), CENTRAL ELECTRICAL DIVISION No. 1, CALCUTTA (*Alternate*)	
SHRI C. C. GIROTRA	Association of Indian Engineering Industry, New Delhi
SHRI R. S. AGGARWAL (*Alternate*)	
SHRI S. P. GUPTA	Central Mechanical Engineering Research Institute (CSIR), Durgapur
SHRI S. K. HARI	Malik Meters Private Ltd, Bombay
SHRI M. K. SINHA (*Alternate*)	
DR J. JAIN	Tata Engineering & Locomotive Co Ltd, Jamshedpur
PROF A. P. JAMBULINGAM	Indian Society for Technical Education, New Delhi

(*Continued on page* 2)

(*Continued from page* 1)

Members	*Representing*
JOINT DIRECTOR (M & C), RDSO, LUCKNOW	Ministry of Railways
CHEMIST AND METALLURGIST, INTEGRAL COACH FACTORY, PERAMBUR (*Alternate* I)	
PRODUCTION ENGINEER (SHELL), INTEGRAL COACH FACTORY, PERAMBUR (*Alternate* II)	
SHRI M. T. KANSE	Directorate General of Supplies & Disposals (Inspection Wing)
SHRI S. N. BASU (*Alternate*)	
SHRI R. KRISHNAMURTHY	Bharat Heavy Electricals Ltd, Tiruchchirappalli
SHRI N. K. SETHI (*Alternate*)	
MANAGING DIRECTOR TAMIL NADU PUBLIC WORKS ENGINEERING CORPORATION	Public Works Department, Government of Tamil Nadu, Madras
SHRI N. MUKHERJEE	Indian Oxygen Ltd, Calcutta
SHRI R. PURKAYASTHA (*Alternate*)	
SHRI N. MUM MOORTHY	Engineer-in-Chief's Branch, Army Headquarters, New Delhi
SHRI M. K. TADANI (*Alternate*)	
SHRI N. C. PANDAY	Central Boilers Board, New Delhi
SHRI K. M. POLE	Walchandnagar Industries, Walchandnagar
SHRI G. D. APTE (*Alternate*)	
SHRI A. K. POTE	Apar Private Ltd, Bombay
SHRI J. R. UPADHYAY (*Alternate*)	
SHRI H. L. PRABHAKAR	Larsen & Toubro Ltd, Bombay; *and* Chemical Plant and Machinery Association of India, Bombay
SHRI J. R. PRASHER	Engineers India Ltd, New Delhi
DR V. RAMASWAMY	Research and Development Centre for Iron & Steel, Hindustan Steel Ltd, Ranchi
DR K. V. SUBBA RAO (*Alternate*)	
SHRI P. B. RAO	Ministry of Defence (DGI)
SHRI S. GANGOPADHYAY (*Alternate*)	
SHRI V. S. G. RAO	Department of Atomic Energy, Bombay
SHRI L. M. TOLANI (*Alternate*)	
REPRESENTATIVE	Indian Institute of Welding, Calcutta
REPRESENTATIVE	National Metallurgical Laboratory (CSIR), Jamshedpur
SHRI A. P. SANYAL	Bharat Heavy Plate & Vessels Ltd, Visakhapatnam
SHRI R. D. PENNATHUR (*Alternate*)	
SHRI V. V. SATHYANARAYANA	Mining & Allied Machinery Corporation Ltd, Durgapur
SHRI S. K. BANERJIA (*Alternate*)	
SHRI S. K. SENGUPTA	Bhilai Steel Plant (HSL), Bhilai
SHRI V. V. KAVISWAR (*Alternate*)	
SHRI G. S. SETHI	Directorate General of Employment and Training, New Delhi
SHRI H. K. SHARMA	Directorate General of Technical Development, New Delhi
SHRI K. C. SHARMA (*Alternate*)	

(*Continued on page* 18)

Indian Standard

SPECIFICATION FOR COPPER AND COPPER ALLOY COVERED ELECTRODES FOR MANUAL METAL ARC WELDING

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 November 1977, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard prescribes requirements for copper and copper alloy covered electrodes for manual metal arc welding.

0.3 This standard includes only commonly used types of electrodes. Detailed description of the various types of electrodes, their characteristics and uses have been given for information in Appendix B to assist the user in specifying and selecting the correct electrode.

0.4 This standard specifies tests which require the use of copper and copper alloys of similar composition and in wrought form as the base metal for preparing various test specimens. Due to non-availability of these alloys in the wrought form, copper alloys in cast form are in vogue. Due to this situation it may not be possible to conduct the guided bend test. The technical committee responsible for the preparation of this standard feels that the guided bend test may not be conducted till such time copper and copper alloys are available in the wrought form. This relaxation is subject to review after a period of three years from the date of publication of this standard.

0.5 In the formulation of this standard, assistance has been derived from AWS A 5.6-69 Specification for copper and copper alloy arc welding electrodes issued by the American Welding Society.

---

1. SCOPE

1.1 This specification covers the requirements for copper and copper alloy covered electrodes having core wire of chemical composition given in Table 1.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 812-1957* shall apply.

3. SUPPLY OF MATERIAL

3.1 General requirements relating to the supply of copper and copper alloy covered electrodes shall be as laid down in IS : 1387-1967†.

4. CLASSIFICATION

4.1 The electrodes are classified on the basis of chemical composition of core wires (*see* Table 1) and mechanical properties of the weld metal (*see* Table 2).

4.2 Any electrode classified under one classification shall not be classified under any other classification.

4.3 The electrodes are classified into five groups as Cu, CuSi, CuSn, CuNi and CuAl based on composition of core wire used to make the electrode in respective groups. In each group Cu represents the basic element and other elements represent major alloying elements present in the core wire. Each group can also be sub-divided by suffixing an alphabet or an alphabet and a digit to the main group to indicate the variation in chemical composition.

4.4 The prefix letter 'E' shall indicate that these are arc-welding electrodes.

5. MANUFACTURE

5.1 The electrodes may be made by any method that will yield a uniform product conforming to the requirements of this standard.

6. GENERAL REQUIREMENTS

6.1 Standard Sizes and Length — The size of electrodes shall be designated by the diameter of the core wire expressed in millimetres.

---

*Glossary of terms relating to welding and cutting of metals.
†General requirements for the supply of metallurgical materials (*first revision*).

The sizes together with corresponding lengths of electrodes are given below:

Designation of the Electrode Size	*Diameters of the Core Wire*	*Length*
	mm	mm
2·00	2·00	300
2·50	2·50	300
3·15	3·15	350/450
4	4·00	350/450
5	5·00	350/450
6·30	6·30	350/450

6.2 Tolerance on Core Wire Diameter — The specified core wire diameter shall not vary by more than ±0·05 mm.

6.3 Tolerance on Length of Electrode — The tolerance on the length of individual electrodes over nominal length shall be ±3 mm.

6.4 The contact length of the electrodes shall be bare and clean to a length of 20 to 30 mm.

6.5 The arc striking end of the electrode shall permit easy striking of arc. Where the end is bare, the distance from the arc end to the first point where the full cross-section of covering prevails, shall not exceed 2 mm or half the diameter of the core wire whichever is the less.

6.6 Covering — The flux covering shall comply with the requirements given in **6.6.1** to **6.6.4**.

6.6.1 *Uniformity* — The covering shall be uniform in outside diameter and in thickness. The tolerance permitted for uniformity of covering (*see* Fig. 1) shall be such that the maximum core plus one covering dimensions shall not exceed the minimum core plus one covering dimension by more than 5 percent of the mean of the two dimensions.

6.6.2 The covering of covered electrodes shall be such that it is not readily damaged by normal handling.

6.6.3 Core wire and coverings shall be free of defects, such as pitings and burrs that would interfere with uniform performance of the electrode.

6.6.4 The covering of an electrode shall fuse and/or burn evenly.

7. CHEMICAL COMPOSITION

7.1 The chemical composition of the core wire shall conform to the requirements of Table 1.

TABLE 1 CHEMICAL COMPOSITION OF CORE WIRE

(*Clauses* 1.1, 4.1 *and* 7.1)

Common Name	IS Classification	Chemical Composition, Percent											
		Copper (Including Silver)	Zinc	Tin	Manganese	Iron	Silicon	Nickel Including Cobalt	Phosphorus	Aluminium	Lead	Titanium	Total Other Elements
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Copper	ECu	98·0 min	*	1·0	0·5	*	0·50	*	0·15	0·01*	0·02*	—	0·50
Copper-silicon (Silicon bronze)	ECuSi	Remainder	*	1·5†	1·5†	0·5	2·8 to 4·0	*	*	0·01*	0·02*	—	0·50
Copper tin (Phosphor bronze)	ECuSn-A	Remainder	*	4 to 6	*	*	*	*	0·10 to 0·35	0·01*	0·02*	—	0·50
	ECuSn-C	Remainder	*	7 to 9	*	*	*	*	0·05 to 0·35	0·01*	0·02*	—	0·50
Copper nickel	ECuNi	Remainder	*	*	2·5	0·40 to 0·75	0·50	29 min	—	—	0·02*	0·5	0·50
Copper-aluminium (aluminium bronze)	ECuAl-A1	Remainder	0·20	—	—	—	0·10	—	—	8 to 9	0·02	—	0·50
	ECuAl-A2	Remainder	0·02	—	—	1·5	0·10	—	—	9 to 11	0·02	—	0·50
	ECuAl-B	Remainder	0·20	—	—	3 to 4·25	0·10	—	—	11 to 12	0·02	—	0·50

NOTE 1 — Analysis shall be made for the elements for which specific values are shown in this table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that the total of those other elements is not present in excess of the limits specified for 'total other elements' in the last column in the table.

NOTE 2 — Single values shown are maximum percentages, except where otherwise specified.

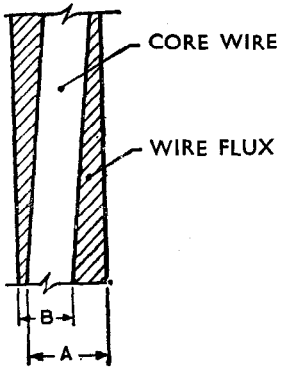
NOTE 3 — Total other elements, including the elements marked with an asterisk (*) shall not exceed the value specified.

NOTE 4 — One or both of these elements marked with a dagger (†) may be present within the limits specified.

TABLE 2 TENSILE STRENGTH REQUIREMENTS

(*Clauses* 4.1, 10.1.1 *and* 11.1)

IS Classification	Tensile Strength, *Min* MPa (kgf/mm^2)
ECu	170 (18)
ECuSi	345 (35)
ECuSn-A	240 (25)
ECuSn-C	275 (28)
ECuNi	345 (35)
ECuAl-A1	380 (39)
ECuAl-A2	410 (42)
ECuAl-B	445 (45)



$$A - B \leqslant \frac{5}{100}\left(\frac{A+B}{2}\right)$$

where

A = minimum core plus one covering dimension, and

B = minimum core plus one covering dimension.

Fig. 1 Permissible Tolerance for Flux Covering

7.2 Chemical analysis shall be made according to IS : 440-1964* and IS : 4027-1967†.

*Methods of chemical analysis of copper (*revised*).

†Methods of chemical analysis of bronzes.

8. MECHANICAL TESTS

8.1 The mechanical tests given in **8.1.1** and **8.1.2** are prescribed to demonstrate the mechanical properties, soundness and ductility of the deposited metal obtained from the electrodes classified in **4.3.**

8.1.1 A transverse-tension test to determine the mechanical properties of a joint made with the electrode being tested.

8.1.2 A transverse guided-bend test to demonstrate the soundness and ductility of weld metal obtained from the electrode being tested.

9. METHODS OF TESTS

9.1 The prescribed tests, when conducted, shall be as specified in Appendix A.

10. MECHANICAL TEST REQUIREMENTS

10.1 In order to be classified under this specification an electrode shall be capable of yielding the results given in **10.1.1** and **10.1.2.**

10.1.1 The tensile strength of each of the two transverse-tension test specimens shall conform to the requirements prescribed in Table 2.

10.1.2 The transverse guided-bend test specimens, after bending, shall show no cracks or other open defects exceeding 1·5 mm along the direction of weld and one mm in the perpendicular direction. Cracks occurring on corners of a specimen testing shall not be considered.

11. RETESTS

11.1 If either transverse-tension test specimen fails, one additional test assembly shall be prepared and the two specimens from this assembly shall conform to the tensile properties prescribed in Table 2.

11.2 If either transverse guided-bend test specimen fails, one additional test assembly shall be prepared and the two specimens removed from this assembly shall meet the prescribed requirements.

12. PACKAGING

12.1 Standard size packages for covered electrodes shall be of 1, 2, 5, 10, and 20 kg net weight.

12.2 Electrodes shall be suitably packed to guard against damage during transportation. The packing shall be suitable to ensure that under normal store room conditions, the electrodes shall, for a period of at least 6 months after the despatch from the manufacturer's stores, be capable of giving results in accordance with the provisions of this

standard and that if the flux covering is of a type requiring special protection during storage the details of such special protection shall be furnished by the manufacturer and reference to this should be included in the marking of the bundle or box of electrodes. The electrodes shall be stored in a dry store room.

12.3 Each bundle or package shall contain the manufacturer's certificate guaranteeing that the electrodes therein comply with the physical and performance requirements set forth in this standard.

12.3.1 The batch of electrodes represented by the electrodes tested shall not be certified as complying with the specification unless the test results obtained satisfy the requirements specified and the manufacturer has performed tests at intervals in accordance with the requirements of this specification.

12.3.2 If the marking on the bundle includes the ISI Certification Mark (*see* **14.1.1**), the manufacturer's certificate need not be included.

13. TEST RESULTS

13.1 On request, as evidence that the electrodes supplied comply with the requirements of this specification, the manufacturer shall produce the results of the most recent periodic check tests carried out within the preceding 12 months on the electrodes representative of the electrodes supplied.

13.2 If a test certificate giving the results of the initial tests carried out on the type of electrode supplied is requested, it shall be made available by the manufacturer (*see* **7.2**, **8.1** and **9.1**).

13.3 If required by the purchaser, the manufacturer shall furnish a test certificate by mutual agreement for each batch of electrode supplied.

14. MARKING

14.1 Each bundle or package of electrodes shall be clearly marked with the following information:

a) Code marking;
b) Name of manufacturer;
c) Trade designation of electrodes;
d) Size;
e) Batch number (*see* Note);
f) Recommended current range;
g) Recommendations for special storage conditions and redrying before use, if required (*see* **12.2**); and
h) Date of manufacture.

NOTE — For the purpose of this standard, a batch is defined as being of the same dry mix, core wire and the same cast number.

14.1.1 The bundle or package of electrodes may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

14.2 The electrodes may also be colour coded in accordance with IS : 5462-1969*.

APPENDIX A

(*Clause* 9.1)

DETAILS OF TESTS

A-1. GENERAL

A-1.1 The tests specified in **7** and **8** shall be conducted in accordance with the requirements of this appendix.

A-1.2 Chemical analysis shall be made on electrodes of all sizes.

A-1.3 Electrodes of 3·15 or larger size for initial tests, and 3·15 for periodic check tests are to be used in making the mechanical tests.

A-2. MATERIALS FOR TEST PLATES

A-2.1 The base metal to be used for test plates shall be in the wrought form and of the type prescribed in Table 3 for the classification under which the electrode is to be tested. When parent metal of the required type is not available it shall be mutually agreed to between the purchaser and the supplier.

A-3. CHEMICAL ANALYSIS

A-3.1 Sufficient quantity of core wire shall be used to make the prescribed chemical analysis. Chemical analysis may be made by any suitable method (*see* **7.2**). Alternatively, a certified casting shop analysis may be used.

*Colour code for identification of covered electrodes for metal arc welding.

TABLE 3 PARENT METAL FOR TRANSVERSE TENSILE AND TRANSVERSE GUIDED-BEND TEST SPECIMENS

(*Clause* A-2.1)

ELECTRODE CLASSIFICATION	APPROXIMATE COMPOSITION	CONDITION
ECu	99·9 Cu	Deoxidized, low phosphorus content, Annealed or hot rolled and annealed
ECuSi	3·2 SiCu	Annealed
ECuSn-A	4·5 SnCu	Soft
ECuSn-C	8 SnCu	Soft
ECuNi	31 NiCu	Annealed
ECu Al-A1	8 AlCu	Annealed
ECu A1-A2 ECu Al-B	7 Al_2FeCu	Annealed

A-4. TEST ASSEMBLY

A-4.1 Welding of the test assembly for transverse-tension and transverse guided-bend tests shall be done using welding techniques specified by the supplier of the particular electrode under tests as to factors not specified in this standard.

A-4.2 All welding shall be done in the flat position.

A-4.3 The test specimen shall conform to the dimensional requirements shown in Fig. 2.

A-4.4 Test assemblies shall be within the temperature ranges shown in Table 4 before starting to weld each pass. If, after any pass, the maximum temperature specified is exceeded, plates shall be allowed to cool in air to within the specified temperature range. Water shall not be used for cooling.

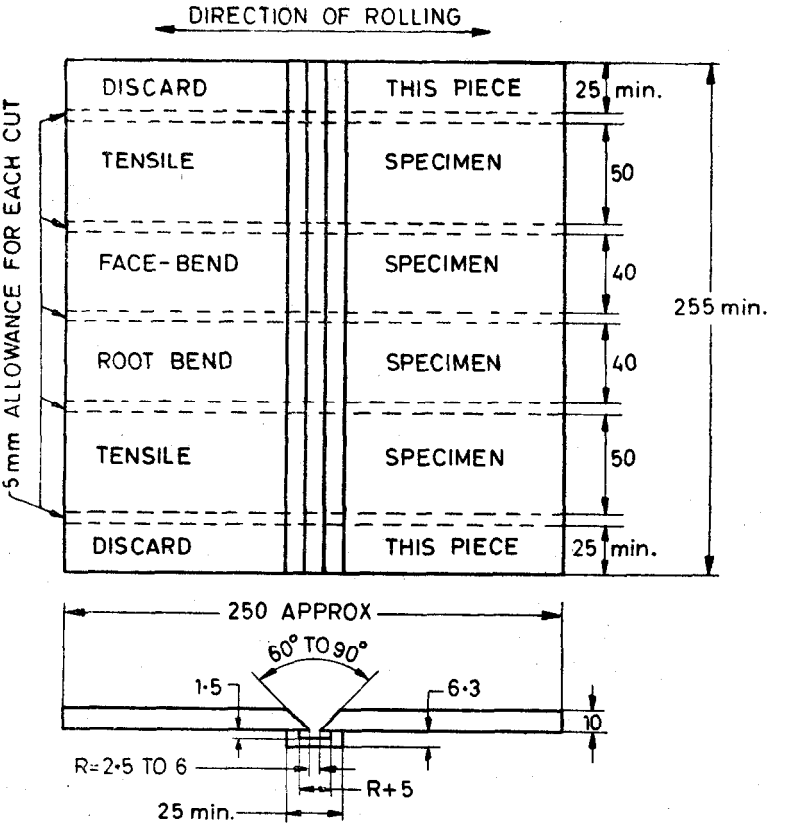
A-5. TRANSVERSE-TENSION TEST

A-5.1 Two transverse-tension test specimens shall be machined from the test assembly. Both specimens shall conform to the dimensional requirements shown in Fig. 3.

A-5.2 Each specimen shall be subjected to tension load until failure.

A-6. TRANSVERSE GUIDED BEND TEST

A-6.1 One face-bend and one root-bend test specimen shall be machined from the test assembly. Both specimens shall conform to the dimensional requirements shown in Fig. 4.



NOTE — Backing may be of same material as base metal, copper or carbon may also be used.

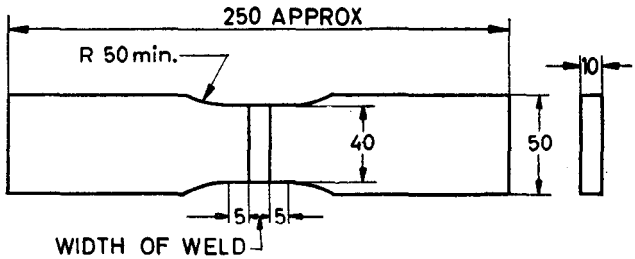
All dimensions in millimetres.

FIG. 2 TEST ASSEMBLY

TABLE 4 TEMPERATURE RANGES OF TEST ASSEMBLIES MADE WITH SHIELDED METAL ARC WELDING PROCESS

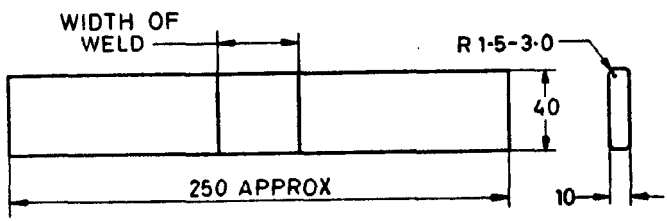
(*Clause* A-4.4)

IS CLASSIFICATION	TEST ASSEMBLY TEMPERATURE RANGE	
	Minimum °C	Maximum °C
ECuSi	30	75
ECuSn	200	275
ECuNi	30	110
ECuAl	150	200



NOTE — Weld reinforcement shall be removed flush with base metal; under cut shall not be removed. Final machining shall be in a direction transverse to the weld.

FIG. 3 TRANSVERSE-TENSION TEST SPECIMEN



NOTE — Weld reinforcement shall be removed flush with base metal; under-cut shall not be removed. Final machining shall be in a direction transverse to the weld.

All dimensions in millimetres.

FIG. 4 TRANSVERSE GUIDED-BEND TEST SPECIMEN

A-6.2 Each specimen shall be bent in a jig having the working contour shown in Fig. 5 and otherwise made substantially in accordance with Fig. 5. Any convenient means may be used for moving the plunger member in relation to the die member. The specimen shall be placed on the die member with the weld at mid-span. Face-bend specimens shall be placed with the face of the weld in tension; root-bend specimens shall be placed with the root of the weld in tension. The two jig members shall be forced together until the specimen conforms to a U-shape and until a 0·8 mm diameter wire cannot be placed between the specimen and any point on the curvature of the plunger member. The specimen shall then be taken out of the jig and the convex surface examined.

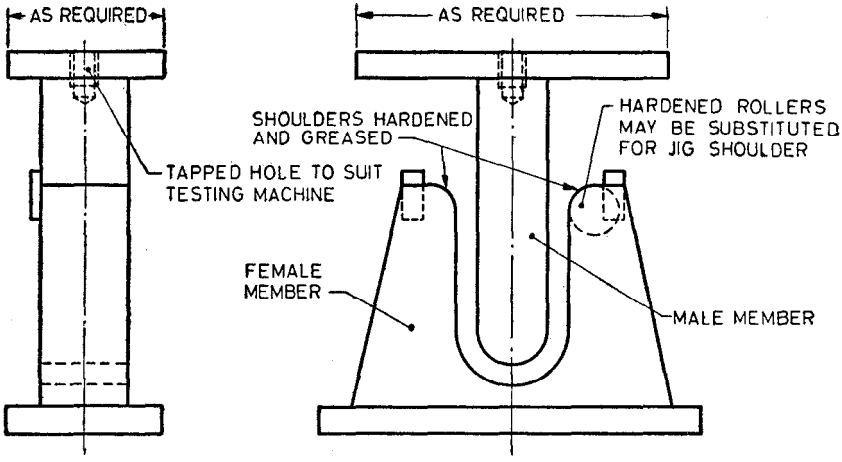


FIG. 5 TYPICAL JIG GUIDED-BEND TEST

APPENDIX B

(*Clause* 0.3)

GUIDE TO IS CLASSIFICATION OF COPPER AND COPPER ALLOY COVERED ARC WELDING ELECTRODES

B-1.0 Introduction

B-1.1 This guide is appended as a source of information; it is not mandatory and does not form a part of the specification.

B-1.2 The specification itself is intended to provide both the manufacturer and the purchaser of copper and copper-alloy welding electrodes with a means of production control and a basis of acceptance through mutually acceptable, sound, and standard requirements.

B-1.3 This guide has been prepared as an aid to users of the copper and copper alloy electrodes covered by the specification in determining which classification of electrode is best suited for a particular application, with due consideration to the particular requirements for that application.

B-1.4 Tests for hardness are not included in this specification. For reference, however, a chart of typical hardness is included as Table 5 of this guide. Each of the basic classification groups is discussed in the parts of this guide that follow.

TABLE 5 HARDNESS OF COPPER AND COPPER ALLOY WELD METAL

IS Classification	Brinell Hardness
ECu	25 to 40 HRF
ECuSi	80 to 100 HB 10/500
ECuSn-A	70 to 85 HB 10/500
ECuSn-C	85 to 100 HB 10/500
ECuNi	60 to 80 HB 10/500
ECuAl-A2	130 to 150 HB 10/3 000
ECuAl-B	140 to 180 HB 10/3 000

Note — Hardness values as listed above are the average values for an as welded pad made with the electrode specified. This table is included for information only; hardness testing is not required under this specification.

B-1.5 It is recognized that supplementary tests may be necessary to determine the suitability of these electrodes for applications involving properties not considered in this specification. In such cases, additional tests to determine such specific properties as corrosion resistance, mechanical properties at low and high temperatures, and suitability for welding combinations of dissimilar metals may be conducted upon agreement between the manufacturer and the purchaser.

B-2. COPPER ELECTRODES (RCu CLASSIFICATION)

B-2.1 Copper is, generally speaking, of three types; deoxidized; oxygenfree; and electrolytic tough pith. The last type is not used generally in welding if a welded joint requiring the strength of the base metal is desired. However, where highest quality is not required, it is being used. The deoxidized coppers, on the other hand, can be welded, producing joints of maximum strength.

B-2.2 ECu covered electrodes are deoxidized and strengthened with silicon, often with additions of tin and manganese, and will deposit the soundest weld metal.

B-2.3 The thinner thicknesses of base metal heat up rapidly enough ahead of the arc so that an external source of preheat may not be needed. However, with thicknesses above 6·3 mm it becomes desirable to provide adequate preheat in the range of 200 to 500°C.

B-3. COPPER SILICON ELECTRODES (ECuSi CLASSIFICATION)

B-3.1 ECuSi electrodes contain approximately 3 percent silicon and may also contain small percentages of manganese and tin. They are used primarily for welding copper-silicon alloys but may also be useful for welding copper zinc alloys and copper.

B-3.2 The electrodes may be used for the fabrication of the silicon bronzes where it is uneconomical or impractical to use gas shielded metal arc welding.

B-3.3 They are occasionally used for the joining of copper, dissimilar metals, and some iron base metals. Silicon bronze deposits are seldom used for surfacing bearing surfaces but are often used to surface areas subjected to corrosion. The electrodes are used with dc, reverse polarity (electrode positive) and operate in a manner similar to mild steel electrodes.

B-4. COPPER TIN ELECTRODES (ECuSn CLASSIFICATION)

B-4.1 ECuSn electrodes are used for joining phosphor bronzes of similar compositions. They are also useful for joining brasses and, in some cases, for welding them to cast iron and mild steel. The electrodes are designed for use with dc reverse polarity. Phosphor bronze electrodes have a tendency to flow sluggishly, requiring preheat and interpass temperature of at least 200°C, especially on heavy sections. Post-weld heat treatment may not be necessary but it is desirable for maximum ductility, particularly if the weld metal is cold worked. Moisture, both on the work and in the electrode coverings, must be strictly avoided. Baking the electrode at 125 to 150°C before use may be necessary.

B-4.2 ECuSn-A — Electrodes conforming to classification ECuSn-A are used primarily for joining plates of similar composition. They may also be used for welding copper if the resultant weld metal is satisfactory for the application as to electrical conductivity and corrosion resistance.

B-4.3 ECuSn-C — The higher tin content electrodes of classification ECuSn are particularly useful in providing weld metal of greater hardness than obtained with ECuSn-A electrode. The ECuSn-C electrodes also provide higher tensile and yield strengths than those of the lower tin content ECuSn-A electrodes.

B-5. COPPER NICKEL ELECTRODES (ECuNi CLASSIFICATION)

B-5.1 Electrodes of the ECuNi classification are most commonly used for joining copper-nickel alloys. They are generally used with dc reverse polarity with a medium to short arc. Although they may be used in all positions, welding is preferably done in flat position. In general, no

preheat is needed. Supplementary additions of manganese may be made to the weld deposit through the covering which will raise the total manganese content of the deposit to 2·5 percent. The covering may also substantially lower the titanium content.

B-6. COPPER ALUMINIUM ELECTRODES (ECuAl CLASSIFICATION)

B-6.1 Copper aluminium electrodes are of two types: the copper aluminium alloy (ECuAl-A1), and the copper aluminium-iron alloys (ECuAl-A2 and ECuAl-B).

B-6.2 ECuAl-A1 (Iron-Free) — Electrodes of this classification are used primarily for the fabrication of annealed aluminium bronze plate, sheet, and strip and for the repair of castings having a similar composition. They are also used to surface bearing and corrosion resistance surfaces.

B-6.3 ECuAl-A2 (Iron-Bearing) — These electrodes are used for joining aluminium bronzes of similar composition, high strength copper zinc alloys, silicon bronzes, manganese bronzes, some nickel alloys, many ferrous metals and alloys, and combinations of dissimilar metals. The weld metal is also suitable for surfacing of bearing, wear and corrosion-resistant surfaces.

B-6.4 ECuAl-B — These electrodes produce a deposit having a higher tensile strength, yield strength and hardness with a correspondingly lower ductility than electrodes of the ECuAl-A2 classification. ECuAl-B electrodes are used for repairing castings as well as the surfacing of bearing, wear and corrosion-resistant surfaces.

B-6.5 The aluminium bronze electrodes of the ECuAl-A2 and ECuAl-B classifications are available for use with dc reverse polarity. The electrodes are used in the flat position only. For butt welds, a 90 deg single-vee groove is recommended for plate thickness up to and including 10 mm and a modified U or double-vee groove is recommended for the heavier plate thickness. Preheat and interpass temperatures should be 100-150°C for iron-base metals, 150-200°C for bronzes and 250-300°C for brasses.

(*Continued from page* 2)

Members	*Representing*
SHRI S. G. N. SWAMY	Mukand Iron and Steel Works Limited, Bombay
SHRI R. K. SRIVASTAVA (*Alternate*)	
SHRI C. R. RAMA RAO, Director (Struc & Met)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI M. S. NAGARAJ
Deputy Director (Struc & Met), ISI

Subcommittee for Welding Consumables, SMDC 14 : 1

SHRI K. R. ANANT RAM	ACC-Vickers-Babcock Ltd, Durgapur
SHRI S. N. MOOKERJI (*Alternate*)	
SHRI S. K. BASU	Indian Oxygen Ltd, Calcutta
SHRI R. BANERJEE (*Alternate*)	
DEPUTY DIRECTOR (MET-I), RDSO, LUCKNOW	Ministry of Railways
CHEMIST AND METALLURGIST, INTEGRAL COACH FACTORY, PERAMBUR (*Alternate*)	
SHRI D. S. HONAVAR	D & H Secheron Electrodes Ltd, Indore
SHRI A. C. MUKHERJEE (*Alternate*)	
SHRI R. KRISHNAMURTHI	Bharat Heavy Electricals Ltd, Tiruchchirappalli
SHRI J. C. MAGOO (*Alternate*)	Bharat Heavy Electricals Ltd, Hardwar
SHRI S. V. NADKARNI	Advani Oerlikon Limited, Bombay
SHRI P. S. VISVANATH (*Alternate*)	
SHRI G. T. PAUL RAJ	Ministry of Defence
SHRI A. K. POTE	Apar Private Ltd, Bombay
SHRI J. R. PRASHER	Engineers India Ltd, New Delhi
SHRI M. R. C. NAGARAJAN (*Alternate*)	
REPRESENTATIVE	Bharat Heavy Plate & Vessels Ltd, Visakhapatnam
REPRESENTATIVE	Power Projects Division, Bhabha Atomic Research Centre, Bombay